# Biodiversity of aquatic insects in kalsa river (Chanfi) of Nainital district, Uttarakhand, India.

**Abstract:** Aquatic insects are the most species-rich group that inhabit freshwaters. They are connected to water by at least one life stage, usually that of the larvae, and some spend their entire life in freshwater habitats. The majority of aquatic insects' larvae develop in water; while adults emerge and spend their lives primarily in terrestrial environments where they mate, disperse and in some cases feed. Aquatic insects are important components of stream food webs and are greatly impacted by anthropogenic disturbances, including urbanization. A study was conducted in Kalsa River, Nainital District to understand the diversity of insects in the area by using sweep-net method and analysis by respected equation and indexes. The study recorded 259 numbers of individuals which divided into 4 orders, namely Lepidoptera, Hymenoptera, Coleoptera, Diptera, and Orthoptera. Trichoptera, Odonata and Hemiptera was dominant order, were as Diptera is least dominant among all the reported orders.The Shannon-Wiener diversity index was highest in site, at (H'=1.79). Evenness was highest at (E=0.38), and the Margalef's Richness Index was (d=1.50). Overall, this study offers a novel method for predicting aquatic insect distribution with high geographic resolution, which aids in the protection of river diversity in the face of anthropogenic and climatic change also this study aimed to identify aquatic insects' species in and provide baseline information for future research.

**Keywords**: Aquatic insects, anthropogenic, urbanization, climate change

## INTRODUCTION

An ecosystem with diversity runs smoothly. The region of Himalayas is always rich in biodiversity both in terrestrial and aquatic bodies. The region of the Western Himalayas relies heavily on freshwater lakes to maintain ecological balance and provide essential ecosystem services. The Himalayas word came from Sanskrit; Hima means 'snow' and laya means 'place'. So, the Himalayas mean ''place of the snow". The three main Himalayan regions are the Western Himalayan Region, the Central Himalayan Region, and the Eastern Himalayan Region (Kumari et.al 2023). In a specific environment, biodiversity includes genetic variation (GV), species variation (SV) and ecosystem variation (EV). Freshwater ecosystems account for less than 0.01% of the Earth's surface, yet they play a vital role in the survival of people and wild-life (Gleick, 1998). In freshwater ecosystems aquatic insects play a pivotal role in many ecological processes such as nutrient cycling, regulation of energy flow and also in biomonitoring of water (Chakravarty *et.al* 2023). However, persistent and ever-increasing anthropogenic disturbance has placed them among the most endangered habitats in an ongoing global freshwater biodiversity crisis (Grigoropoulou *et .al* 2023). Aquatic insects are connected to water by at least one life stage, usually that of the larvae, and some spend their entire life in freshwater habitats. The majority of aquatic insects' larvae develop in water; while adults emerge and spend their lives primarily in terrestrial environments where they mate, disperse and in some cases feed. Aquatic insects are sensitive to environmental conditions, which is why they are widely used in biomonitoring. Mayflies, stoneflies and caddisflies are among the most commonly used indicators, but other taxa also show high potential (Marija *et. al* 2023).

In this scenario, ecological indicators are being widely used because they indicate biotic conditions, physical and chemical characteristics, ecological processes and disturbances that may occur in a water body (Malacarne *et. al* 2023). These organisms are responsible for several ecological services, mainly the bioturbation of the sediment, fragmentation of organic matter from riparian vegetation and transfer of nutrients to various links in the food web (Nery & Schmera, 2016). It is important to emphasize that individuals from the orders of Ephemeroptera, Plecoptera and Trichoptera are well documented as good biological indicators in stream ecosystems (Cíbik, *et. al* 2021). At the same time, some aquatic species of Coleoptera and Hemiptera, show higher sensitivity to sediment addition and organic pollution (Malacarne *et. al* 2023). Dragonflies and damselflies (Odonata) are considered good bioindicator groups to reflect the quality of aquatic systems (Santos &Rodrigues 2022; Veras *et. al* 2022).

These habitats are typically threatened by five major factors: invasive species, habitat deterioration, water pollution, overexploitation, and flow alteration (Dudgeon*et.al*2006).The environmental pollution of water resources is increased due to uncontrolled population growth, urbanisation, industrialization, and excessive use of fertilisers and pesticides in agriculture and other man-made activities. A number of water quality parameters, including Temperature, turbidity, nutrients, hardness, alkalinity, dissolved oxygen, etc., determine the growth of living organisms in a body of water. Kalsa River is a very valuable source of livelihood to its inhabitants and neighbouring community. And also, one of the most important rivers in Uttarakhand state. It serves as a source of drinking water and other domestic activities by its inhabitants. Unfortunately, there is no impact of human activities on this river such as outdoor bathing, washing clothes and dumping of refuse brings about a lot of contamination to the river. Although there was no literature specifically on the abundance and composition of aquatic insect of Kalsa river (Chanfi). The only few researches available in kalsa river near the Chanfi area. Therefore, there is need for this study. The aim of this study is to provide the checklists of various aquatic insect's orders of Kalasa River (Chanfi).

## MATERIALS AND METHODS

The study was carried out for eight months from October,2022 to May,2023, in kalsa river (Chanfi) Nainital. (29°22'36.2"N and 79°29'23.7"E) (Fig:1). The study area is located in Tehsil of Nainital district in Uttarakhand, India. It is situated 25 km away from Nainital. The total geographical area of village is 33.58 hectares. It is beneficial from a moderate climate, mid - level altitude (4,500 feet above sea level) and a spring-fed river as the water source. It has diverse aquatic vegetation such as algae, water lilies and muskgrass as shown in fig. 1 and 2. One first encounters the river meeting point, the 'Jhoola Pull", which is suspension bridge built by the Britisher in 1910 and is the starting point of the trek to solitude by the riverside. The Kalsa river, flow alongside the entire property.

Aquatic insect samples were collected monthly from Kalsa river at site Chanfi from different corner of river. All the samples were collected at 8:00am to 10:00 am local time in 3$^{rd}$ week of every month. Aquatic insects were collected by disturbing the vegetation and dragging a circular pond net around the vegetation for one and two minutes (Subramanian and Sivaramakrishnan, (2007), Dalal and Gupta, (2016). Dragging of pond net was done about one meter, in water and aquatic insects was picked with the help of forceps. Maximum aquatic insects were collected from their natural habitat. They were identified using a Labomed stereo-zoom microscope following standard keys (Saha and Gupta, 2018: Ramaraju *et.al* 2020). Collected insects were immediately sorted and preserved in 70% ethyl alcohol at sites and then in lab we preserved it in a 4% formalin solution (Abhilash, H. R. 2023). The data intercepting by the help of diversity indices.

Diversity Indices

Diversity of aquatic insects calculated by following methods with minute modification:

Shannon-Wiener Diversity Index(H) (Luo *et.al* 2023):

This index is most preferred index among the diversity indexes. This is applied to the biological system derived by Shannon in 1948. The value of index ranges from 0 to 5. The value above 3 indicate balanced and stable habitat (SH), while value below 1 indicates pollution and destructive habitat (DH). The formula is as follows:

$H = -\sum[(pi) \times \log(pi)]$

where:

- $H$ - Shannon diversity index;
- $pi$ - proportion of individuals of i-$^{th}$ species in a whole community;
- $\sum$ - sum symbol; and
- log - usually the natural logarithm, but the base of the logarithm is arbitrary (10 and 2 based logarithms are also used).

$pi = N \div n$

- $n$ - individuals of a given type/species; and
- $N$ - total number of individuals in a community

Margalef's Species Richness Index(d) (Bhede *et,al* 2023; Rekha *et, al*2023) :

Species richness S is the simplest measure of biodiversity and is simply a count of the number of different species in a given area. This measure is strongly dependent on sampling size and effort.

The Margalef diversity index can easily be calculated in a spreadsheet:

$d = (S - 1) / \ln N$

Where S is the number of species, and N is the total number of individuals in the sample.

The data processing was done using Microsoft excel 2010 (Microsoft corporation) and diversity indices were worked using PAST software.

## RESULTS AND DISCUSSION

Aquatic insect composition and abundance

The table 1 and figure 3 show the numbers of aquatic insects present in the Kalsa river near Chanfi area. Total 259 aquatic insects were identified and collected. In which

collected aquatic insects belonging to 7 species and contain 4 different orders. The identified aquatic insects belong to 7 different families. The dominance of aquatic insects was recognized belong to family Rhyacophilodae. Through which we can slightly conclude that the environment is undisturbed and quality of water is decent. The second abundant aquatic insects' family is Cordulegastridae which is recognized belong to order odonata. In order odonata approximate the aquatic insects belong to 3families (Cordulegastridae,Macromiidae,Coenagrionidae). The third most abundant aquatic insects with total 54, belong to order Hemiptera, contains family Gerridae, which show that considered as a potential sentinel for mercury (Hg) contamination of freshwater ecosystems, yet little is known about factors that control Hg concentrations in this invertebrate. Then family Coenagrionidae contain 52 insects which slightly show that help maintain ecological balance within ecosystems, preventing outbreaks of pest species.In order Diptera with family Tabanidae contain 10 aquatic insects. The least aquatic insects that are identified belong to order Odonata, in which Macromiidae family contain 5 aquatic insects through which we can conclude that beneficial insects because they feed on small flying insects such as mosquitoes. Due to less in number the surrounding area have high percentage of risk of disease that related to flying insects like mosquitoes. The pie chart in fig 4 shows that the highest most abundant aquatic insects belong to order Odonata with 115 number of individuals. The second abundant order is Trichoptera with 73 number of individuals. Order Hemiptera with 54 number of individuals and order Diptera contain the least number of individuals. The odonata directly depend connected to ecological factors. As rising temperatures associated with global warming can contribute to strengthen pesticide toxicity, insecticide exposures under increasing temperatures may accelerate the decline of Odonata species in the future. But due higher number of individuals the area is completely toxic free and water is potable for drinking purposes which help the surrounding individual's fight from diseases. The table 2 is showing the presence and absence of insects in the tested site. In Year Oct. and Nov. all complete reported order insects are present but in next 2 months Dec. and in Jan. aquatic insects are less in numbers, might be due to the environment factors. But in next respected year from Feb.to May all the reported order are advanced in number and all the environment factors are supporting to it.

The table 2 calculate and explation the relative abundance % and status of kalsa river at chanfi area. According to Engelmann's scale of dominance (1973) shows that *Rhyacophila sp., Cordulegaster sp., Ischnura sp.* and *Gerris sp.* belong to order Trichoptera, Odonata and Hemiptera were marked as the dominant species. *Macromia sp.* and *Tanytarsus sp.* belong to order Odonata and Diptera were recedent species. Through the status we accomplish that the water is potable for drinking and also help maintain ecological balance within ecosystems, preventing outbreaks of pest species. The fig5shows the % Relative abundance in graphical, of different insects collected from the site kalsa river(Chanfi) during October,2022 to May,2023.From the Figure, it is clear that Rhyacophilodae family, having highest abundance with 28.18%, further it followed by Cordulegastridae family with 22.39%, family Gerridae contain 20.84%, Coenagrionidae contain 20.07% , 3.86% contain by Chironomidae, Tabenidae family

contain 2.70% and last the least relative abundance contain by Macromiidae family with 1.93%. The table 4 and Fig 6shows that from months October to May the Shannon index (H') range from 1.01 to1.79with highest diversity in year March (H'=1.79) and Evenness with highest value in year Jan.(E'=0.38). The Margalef's index range from 0.68 to 1.50 with highest range in year March(M'=1.50).

**Conclusion:**

A study revealed a total of 259 individuals belonging to 7 species of 7families and 4 orders. The study highlighted that Lepidoptera, Odonata and Hemiptera was the most diverse insect order in the area, followed by Lepidoptera which had the maximum number of plants visitors. Although the diversity of Dipterans was relatively less, their contribution cannot be neglected. The average number of aquatic insects present suggests that the region is biologically and ecologically balanced, which could be a sign of a healthy ecosystem. By the analysis of water parameters, the water is potable form human welfare and good for their metabolic process. But when we further conclude the area in respect to relative abundance it showing the nature is not affecting right now. So, we have to preserved it for future welfares.



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**Photograph and figures:**

**Fig1**: Research site

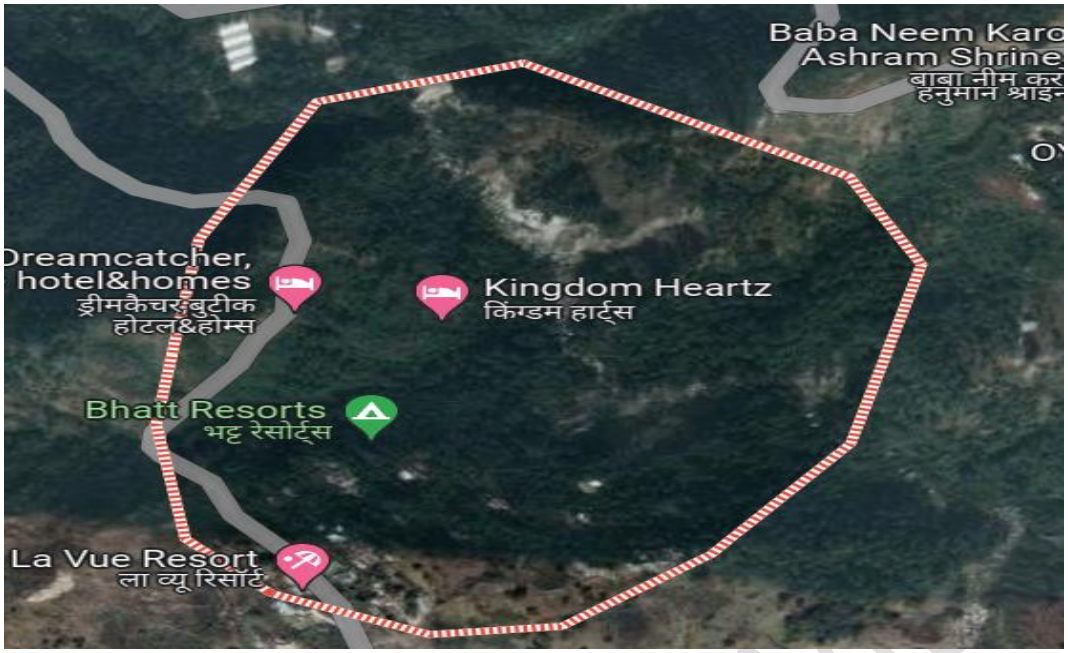


**Fig 2**: Geographical map of research site

**Table 1:** Showing the numbers of aquatic insects' and their belonging orders and families.

| S.No. | Order | Families | Scientific Name | Common Name | No. of aquatic insects |
|---|---|---|---|---|---|
| **1** | Trichoptera | Rhyacophilodae | *Rhyacophila sp.* | Free- Living<br>Green Caddisflies | **73** |
| **2** | Odonata | Cordulegastridae | *Cordulegaster sp.* | Spiketails<br>Biddies | **58** |
| | | Macromiidae | *Macromia sp.* | River cruisers | **5** |
| | | Coenagrionidae | *Ischnura sp.* | Forktrails | **52** |
| **3** | Diptera | Chironomidae | *Tanytarsus sp.* | Non-Biting | **7** |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Midges | |
| | | Tabanidae | *Tabanus sp.* | Horsefly Larva | **10** |
| **4** | Hemiptera | Gerridae | *Gerris sp.* | Water Striders | **54** |
| **Total** | | | | | **259** |

*Rhyacophila sp.*

*Tanytarsus sp.*

*Gerris sp.*

*Tabanus sp.*

a

b

*Ischnura sp.*

*Cordulegaster sp.*

*Macromia sp.*

**Fig:3:** Showing aquatic insects from research site

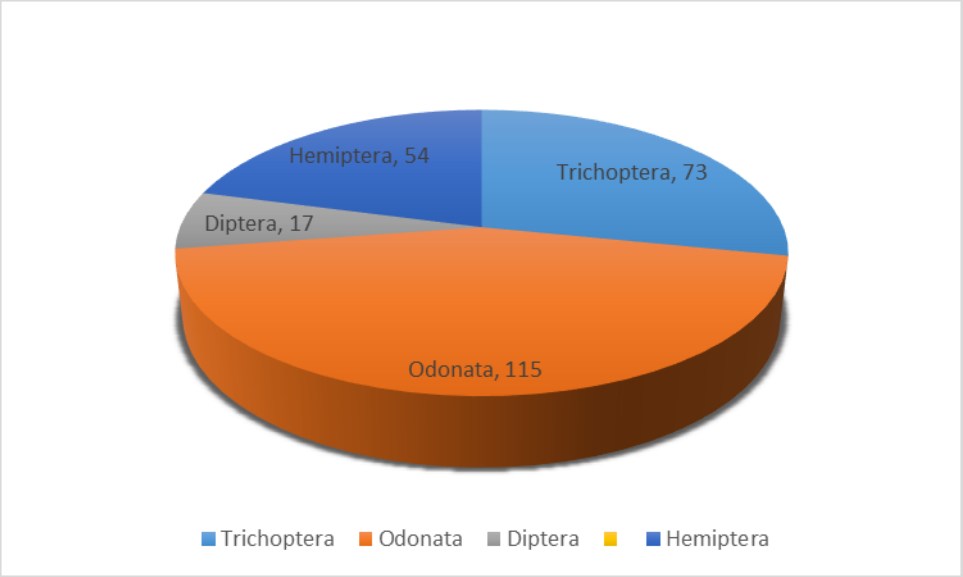


**Fig4:** Showing the number of aquatic insects in kalasa river in respect to orders.

**Table 2:** Monthly variation in the species content of taxa, total species and their %in site Kalsa river (Chanfi) during October 2022 to May,2023.

| **S.No.** | **Order** | **Taxonomic Composition** | **2022-2023** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Oct.** | **Nov.** | **Dec.** | **Jan.** | **Feb.** | **Mar.** | **Apr.** | **May** |
| **1** | Trichoptera | *Rhyacophila sp.* | + | + | - | - | + | + | + | + |
| **2** | Odonata | *Cordulegaster sp.* | + | + | - | - | + | + | + | + |
| | | *Macromia sp.* | + | + | - | - | + | + | + | + |
| | | *Ischnura sp.* | + | + | - | - | + | + | + | + |
| **3** | Diptera | *Tanytarsus sp.* | + | + | - | - | + | + | + | + |
| | | *Tabanus sp.* | + | + | - | - | + | + | + | + |
| **4** | Hemiptera | *Gerris sp.* | + | + | - | - | + | + | + | + |

+ = present and - = Absent

**Table 3:** Composition and %Relative abundance (RA) of aquatic insects in kalsa river during October 2022-May 2023:

| S.No. | Order | Insect texa | No. of insects | %Relative abundance | Status |
|---|---|---|---|---|---|
| **1** | Trichoptera | *Rhyacophila sp.* | 73 | 28.20 | Dominant |
| **2** | Odonata | *Cordulegaster sp.* | 58 | 22.40 | Dominant |
| | | *Macromia sp.* | 5 | 1.93 | Recedent |
| | | *Ischnura sp.* | 52 | 20.07 | Dominant |
| **3** | Diptera | *Tanytarsus sp.* | 7 | 2.70 | Recedent |
| | | *Tabanus sp.* | 10 | 3.86 | Subdominant |
| **4** | Hemiptera | *Gerris sp.* | 54 | 20.84 | Dominant |
| | Total | | 259 | 100 | |

%RA < 1 = Subrecedent; 1.1-3.1 = Recedent; 3.2-10 = Subdominant; 10.1-31.6 = Dominant; > 31.7% = Eudominant.



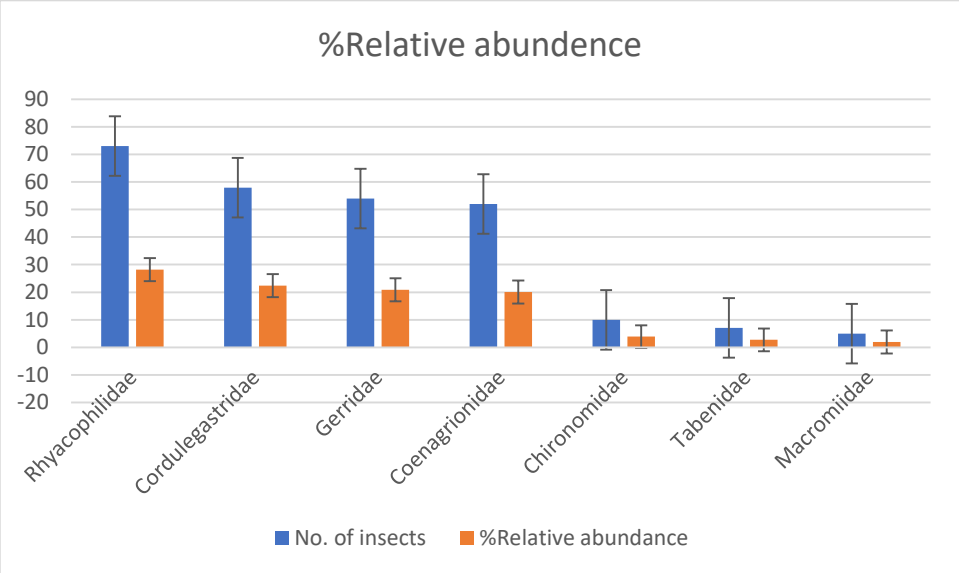


**Fig:5**: Showing the relative abundance

**Table 4:** Diversity indices of Lepidoptera collected in Kalsa river (Chanfi) during October,2022 to May, 2022.

| S.No. | Months | Shannon index(H') | Evenness (E) | Margalef's index (d) |
|---|---|---|---|---|
| **1** | October | 1.36 | 0.34 | 0.83 |
| **2** | November | 1.06 | 0.353 | 0.679 |
| **3** | December | 1.02 | 0.32 | 0.68 |
| **4** | January | 1.01 | 0.38 | 0.69 |
| **5** | February | 1.35 | 0.33 | 0.9 |
| **6** | March | 1.79 | 0.25 | 1.50 |
| **7** | April | 1.74 | 0.25 | 1.42 |
| **8** | May | 1.50 | 0.30 | 0.94 |

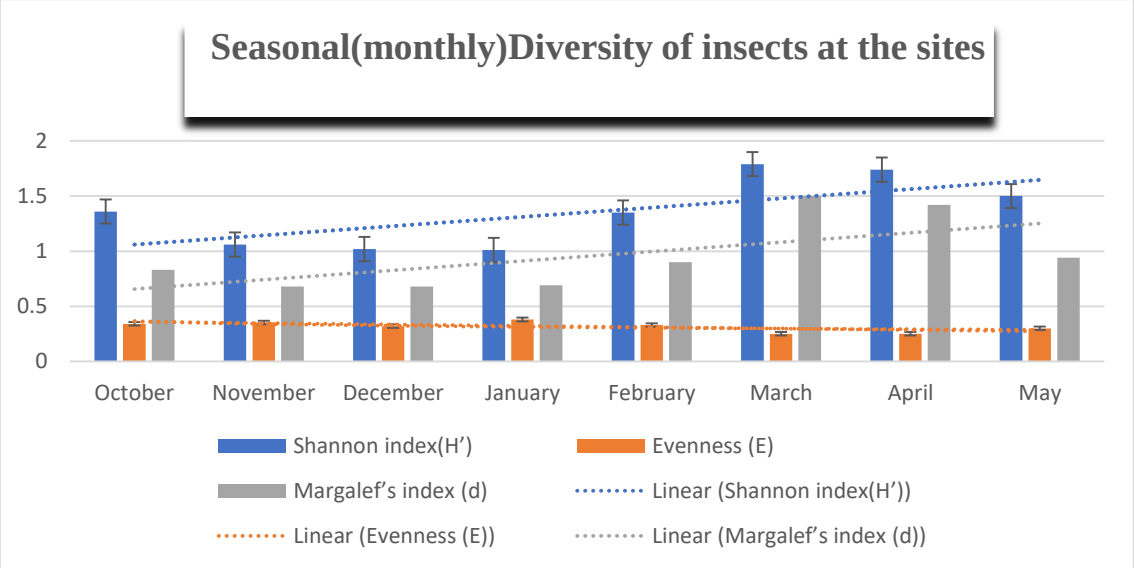


**Fig 6:** Showing Shannon index, Evenness and Margalef's index in respects with trendlines.